Gross Land Use Changes In Delaware
1992 to 1997

Prepared by
the Delaware Office of State Planning Coordination
August, 1999

Introduction

In 1984, 1992 and 1997, the State of Delaware was photographed from the air -- projects spearheaded by the Delaware Department of Transportation. These photographs, known as digital orthophotos, are used by DelDOT to facilitate roadway planning and maintenance. Other state agencies use the photos in support of a wide variety of projects as well.

The 1992 and 1997 digital orthophotography was also used to derive land use and land cover data for the state[1]. In the case of the 1997 photos, this was a collaborative effort funded by a consortium of state agencies. This data provides an opportunity to take a snapshot of the land use and land cover of the state in those years. More importantly, this data can be used to study changes in land use in Delaware over time.

John Mackenzie and Kevin McCullough of the University of Delaware's Spatial Analysis Lab analyzed the 1984 to 1992 land use change in a paper entitled *Delaware Land Use/Land Cover Transitions, 1984 – 1992*. Their findings indicated a continuation of the trend towards urbanization in all three Delaware counties. The 1984 and 1992 data, however, were developed using different methodologies and based on photography with different resolutions[2]. The discussion that follows will refer to the findings of the earlier report, though no attempt at a direct comparison will be made. This due, in part, to the fact that the earlier paper looked at trends over an eight year period and this effort looks at only a five-year period.

Summary

Delaware lost agricultural land and forests in the five years between 1992 and 1997, continuing a trend seen by Mackenzie between 1984 and 1992. The state gained in "developed" uses (residential, urban, commercial, industrial, transportation, government and utility) over the same period. Developed uses grew by almost 14 percent over the period, while the amount of agricultural and forested land was down by nearly four percent. (See Table 1)

The largest change, by percentage, was in the "other" category, which includes brushland, rangeland, barren land and other uses. The largest portion of this gain was seen in Sussex County (See Table 5). This change may reflect an interpretation of forested lands that had been harvested for timber prior to 1992, and were growing back through a "scrub" or "brush" phase in 1997.

Table 1
Gross Land Use Changes, State of Delaware, 1992 - 1997

	1992	1997	Change	
			Acres	Percent
Developed	188,272.43	214,547.89	26,275.46	13.96%
Agricultural/Forest	776,719.27	746,424.30	-30,294.97	-3.90%
Water	45,898.36	47,380.69	1,482.34	3.23%
Wetlands	245,038.79	242,684.63	-2,354.16	-0.96%
Other	27,886.93	32,729.11	4,842.18	17.36%

The 1992 and 1997 data also show a growth in water areas of over three percent. This may indicate a change in interpretation or may be due to differences in the relative wetness of the years in which the aerial photography was

[1] These data sets are available on-line. The 1992 data can be found at http://bluehen.ags.udel.edu/spatlab/lulc. The 1997 data is posted at http://www.state.de.us/planning/info/lulcdata/lulc.htm.
[2] A detailed discussion of the data inconsistencies is available as part of the on-line version of the Mackenzie/McCullough paper, which can be found at http://bluehen.ags.udel.edu/spatlab/lulc/. This site also includes a link to an earlier Mackenzie paper, AES Bulletin 483, *Land Use Transitions in Delaware, 1974 – 1984*.

Table 2
Distribution of Land Uses, State of Delaware, 1992 - 1997

	1992	1997
Developed	14.67%	16.71%
Agricultural/Forest	60.50%	58.14%
Water	3.58%	3.69%
Wetlands	19.09%	18.90%
Other	2.17%	2.55%

taken. There is, however, also a slight decrease in wetland areas. This may reinforce the theory that the water difference is due to interpretation.

Agriculture and forest cover retained the largest combined share of land use in the state though this category dropped from almost 61 percent in 1992 to just over 58 percent of land use in Delaware in 1997. Wetland areas remained the second largest share of land use, changing only slightly over the period. Developed land uses grew from almost 15 percent of the state in 1992 to almost 17 percent in 1997. (See Table 2)

Other categories remained essentially the same, in terms of their share of land use, over the period.

Detailed County Changes

Kent County

Acreage devoted to residential/urban uses grew by over 21 percent between 1992 and 1997 in Kent County. This category grew from just under seven and a half percent of land use in the county in 1992 to over nine percent of land use in Kent County in 1997. Mackenzie had noted a growth of 50 percent in residential uses in Kent County in the eight years between 1984 and 1992.

Commercial/industrial uses grew by almost nine percent between 1992 and 1997, while the combined category of transportation, governmental, and utility uses grew by over six percent. Both of these categories remained a relatively small share of the land use. (See Table 3)

Table 3
Kent County Land Use Change, 1992 - 1997

	1992		1997		Change	
	Acres	%Distr.	Acres	%Distr.	Acres	Percent
Residential/Urban	28,642.82	7.48%	34,710.69	9.06%	6,067.87	21.18%
Commercial/Industrial	4,278.67	1.12%	4,662.01	1.22%	383.34	8.96%
Transportation/Government/Utility	5,295.70	1.38%	5,637.59	1.47%	341.89	6.46%
Agricultural	193,518.56	50.54%	187,152.46	48.87%	-6,366.10	-3.29%
Forest (Incl. Clear Cut)	39,625.08	10.35%	39,385.98	10.29%	-239.10	-0.60%
Water	8,534.86	2.23%	9,250.56	2.42%	715.70	8.39%
Wetlands	98,348.91	25.68%	97,602.82	25.49%	-746.09	-0.76%
Other	4,684.06	1.22%	4,533.89	1.18%	-150.18	-3.21%

Acreage devoted to agricultural uses in Kent County fell by over three percent, though agriculture remained the dominant land use in the county. Agricultural land use fell from nearly a 51 percent share to just under a 49 percent share of land use in Kent County between 1992 and 1997. In the earlier study, Mackenzie noted only a slight loss in farmland between 1984 and 1992. There was, however, a much greater loss of forest in that period.

New Castle County

The largest percent gain in land use in New Castle County between 1992 and 1997 was in the transportation/government/utility category, which grew by over 10 percent. Commercial/industrial land uses grew by almost eight percent. (See Table 4) These categories combined to make up about nine percent of land uses in New Castle County in 1997. This is the largest share of land uses held by these categories among the three counties and reflects New Castle's traditional status as the urban/manufacturing core of the state.

Residential/urban uses, meanwhile, grew by only a little more than eight percent between 1992 and 1997. This was enough, however, when combined with the over six percent drop in agricultural land use, to bring these to categories almost even in terms of their share of land use. The residential/urban category rose from approaching 26 percent to nearly 28 percent of land use, while agricultural uses fell from nearly 31 percent to under 29 percent of land use. Forest areas also saw a decline, dropping by almost six percent.

Table 4
New Castle County Land Use Change, 1992 - 1997

	1992		1997		Change	
	Acres	%Distr.	Acres	%Distr.	Acres	Percent
Residential/Urban	70,484.53	25.51%	76,377.96	27.64%	5,893.43	8.36%
Commercial/Industrial	13,632.84	4.93%	14,680.37	5.31%	1,047.53	7.68%
Transportation/Government/Utility	10,079.88	3.65%	11,108.47	4.02%	1,028.59	10.20%
Agricultural	84,904.25	30.72%	79,642.89	28.82%	-5,261.36	-6.20%
Forest (Incl. Clear Cut)	46,572.81	16.85%	43,888.72	15.88%	-2,684.09	-5.76%
Water	7,124.08	2.58%	7,394.51	2.68%	270.43	3.80%
Wetlands	32,035.82	11.59%	31,908.13	11.55%	-127.69	-0.40%
Other	11,515.33	4.17%	11,352.66	4.11%	-162.68	-1.41%

Between 1984 and 1992, Mackenzie found that the commercial/industrial category grew by 60 percent and residential by 33 percent.

Sussex County

In Sussex County, aside from an increase in "other" (discussed previously), residential/urban land uses showed the strongest growth, increasing by almost 23 percent between 1992 and 1997. These uses still account for only a small share of land uses in Sussex County, however; they increased from over seven percent of Sussex land use in 1992 to just over nine percent in 1997. (See Table 5)

Table 5
Sussex County Land Use Change, 1992 - 1997

	1992		1997		Change	
	Acres	%Distr.	Acres	%Distr.	Acres	Percent
Residential/Urban	46,253.59	7.41%	56,661.09	9.07%	10,407.50	22.50%
Commercial/Industrial	5,555.13	0.89%	6,074.07	0.97%	518.95	9.34%
Transportation/Government/Utility	4,049.28	0.65%	4,635.64	0.74%	586.36	14.48%
Agricultural	278,664.48	44.62%	272,008.87	43.56%	-6,655.61	-2.39%
Forest (Incl. Clear Cut)	133,434.08	21.37%	124,345.37	19.91%	-9,088.71	-6.81%
Water	30,239.41	4.84%	30,735.63	4.92%	496.21	1.64%
Wetlands	114,654.07	18.36%	113,173.68	18.12%	-1,480.39	-1.29%
Other	11,687.53	1.87%	16,842.57	2.70%	5,155.04	44.11%

This may seem counter-intuitive, given the rapid development of portions of the county. It is important to remember, however, just how large Sussex County actually is. It may also be the case that much of the development is concentrated along major transportation corridors, sparing large tracts of land that may be just out of sight.

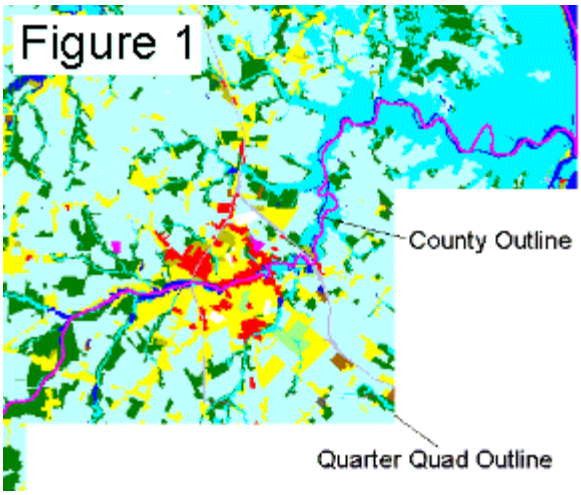
The transportation/government/utility and commercial/industrial categories also showed sharp growth in Sussex County between 1992 and 1997. They grew by over 14 percent and more than 9 percent, respectively. This growth is likely a reflection of the strong residential growth in the County; these uses would have to grow in order to serve the transportation needs and economic needs of an expanding Sussex County population.

Mackenzie had seen the start of that trend in his study, which found 80 percent growth in residential uses and over 100 percent growth in commercial/industrial uses in Sussex County between 1984 and 1992.

Methodology

Land Use/Land Cover data for 1992 and 1997 were derived from aerial photography flown in those years for the Delaware Department of Transportation. The land use/land cover categories follow the *Anderson et al Land Classification System*[3].

[3] See http://www.state.de.us/planning/info/lulcdata/lulccode.txt



Because the 1997 data set was delineated by updating the 1992 data set, the two align very closely to one another. It was necessary to "clip" the 1997 data, however, to prepare it for direct comparison to the 1992 data. The 1997 data included the full expanse of each of the USGS cartographic quarter quads on which the data sets are based. As a result, there was some "bleed over" from one county to another and into other states. (See Figure 1) An outline of each county was created using the 1992 land use/land cover data set. This polygon was used to clip the 1997 data in the ArcView GIS program to "trim" those areas outside of the counties.

As a result, it was possible to make a direct comparison between the two data sets. While it is possible that the outlines derived from the 1992 data set are not exact outlines of the counties in the legal sense, using the 1992 data to develop outlines ensures that the comparison between the two data sets is as accurate as possible.

Once the data sets were "evened up," ArcView's "ReturnArea" command was used to calculate the area of every polygon in each data set. The resulting data set was summarized by land use code to create a detailed data table presenting the total area of each county by each classification in the *Anderson* scheme. This is the data that was used to calculate changes.

Further Assessment

While gross land use changes are interesting, a detailed, polygon-by-polygon examination of changes will be much more useful. That analysis will be undertaken during the summer of 1999 by a professor at the University of Delaware.

Finally, it is important to continue this type of analysis. The changes in land uses between 1992 and 1997 are instructive, but do not present a complete picture of long term land use change in Delaware. It will be important to continue to take snapshots of land use in the state, over a regular series of time intervals, to develop a clear picture of how Delaware is changing. It is important, therefore, to repeat the process of taking aerial photos, and having them interpreted, every five years.